

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

## NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of

Inventor(s): Jarno KNUUTILA, Jari HAMALAINEN, Ari AHO, Marku LIPPONEN,  
Ari SALMINEN

WARNING: 37 C.F.R. § 1.41(a)(1) points out:

"(a) A patent is applied for in the name or names of the actual inventor or inventors.

"(1) The inventorship of a nonprovisional application is that inventorship set forth in the oath or declaration as prescribed by § 1.63, except as provided for in § 1.53(d)(4) and § 1.63(d). If an oath or declaration as prescribed by § 1.63 is not filed during the pendency of a nonprovisional application, the inventorship is that inventorship set forth in the application papers filed pursuant to § 1.53(b), unless a petition under this paragraph accompanied by the fee set forth in § 1.17(f) is filed supplying or changing the name or names of the inventor or inventors."

For (title): DATA TRANSMISSION IN A TDMA SYSTEM

## CERTIFICATION UNDER 37 C.F.R. 1.10\*

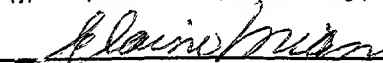
(Express Mail label number is mandatory.)

(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date June 29, 1999 in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL336859616US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Elaine Mian

(type or print name of person mailing paper)



Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

\*WARNING: Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will not be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

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jc625 U.S. PTO  
09/342843  
06/29/99

## 1. Type of Application

This new application is for a(n)

(check one applicable item below)

- ☒ Original (nonprovisional)
- ☐ Design
- ☐ Plant

**WARNING:** Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

**WARNING:** Do not use this transmittal for the filing of a provisional application.

**NOTE:** If one of the following 3 items apply, then complete and attach **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED** and a **NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION**.

- ☐ Divisional.
- ☐ Continuation.
- ☐ Continuation-in-part (C-I-P).

## 2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

**NOTE:** A nonprovisional application may claim an invention disclosed in one or more prior filed copending nonprovisional applications or copending international applications designating the United States of America. In order for a nonprovisional application to claim the benefit of a prior filed copending nonprovisional application or copending international application designating the United States of America, each prior application must name as an inventor at least one inventor named in the later filed nonprovisional application and disclose the named inventor's invention claimed in at least one claim of the later filed nonprovisional application in the manner provided by the first paragraph of 35 U.S.C. 112. Each prior application must also be:

(i) An international application entitled to a filing date in accordance with PCT Article 11 and designating the United States of America; or

(ii) Complete as set forth in § 1.51(b); or

(iii) Entitled to a filing date as set forth in § 1.53(b) or § 1.53(d) and include the basic filing fee set forth in § 1.16; or

(iv) Entitled to a filing date as set forth in § 1.53(b) and have paid therein the processing and retention fee set forth in § 1.21(f) within the time period set forth in § 1.53(f).

37 C.F.R. § 1.78(a)(1).

**NOTE:** If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach **ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED**.

**WARNING:** If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

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**WARNING:** When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- ☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

**3. Papers Enclosed**

- A. Required for filing date under 37 C.F.R. § 1.53(b) (Regular) or 37 C.F.R. § 1.153 (Design) Application

14 Pages of specification

8 Pages of claims

4 Sheets of drawing

**WARNING:** DO NOT submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. For comments on proposed then-new 37 CFR 1.84, see Notice of March 9, 1988 (1990 O.G. 57-62).

**NOTE:** "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page . . ." 37 C.F.R. 1.84(c).

(complete the following, if applicable)

- ☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).
- ☐ formal
- ☐ informal

**B. Other Papers Enclosed**

       Pages of declaration and power of attorney

1 Pages of abstract

       Other

**4. Additional papers enclosed**

- ☐ Amendment to claims
- ☐ Cancel in this applications claims \_\_\_\_\_ before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)
- ☐ Add the claims shown on the attached amendment. (Claims added have been numbered consecutively following the highest numbered original claims.)
- ☐ Preliminary Amendment
- ☒ Information Disclosure Statement (37 C.F.R. 1.98)
- ☒ Form PTO-1449 (PTO/SB/08A and 08B)
- ☒ Citations

- ☐ Declaration of Biological Deposit
- ☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.
- ☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative
- ☐ Special Comments
- ☐ Other

**5. Declaration or oath (including power of attorney)**

*NOTE: A newly executed declaration is not required in a continuation or divisional application provided that the prior nonprovisional application contained a declaration as required, the application being filed is by all or fewer than all the inventors named in the prior application, there is no new matter in the application being filed, and a copy of the executed declaration filed in the prior application (showing the signature or an indication thereon that it was signed) is submitted. The copy must be accompanied by a statement requesting deletion of the names of person(s) who are not inventors of the application being filed. If the declaration in the prior application was filed under § 1.47, then a copy of that declaration must be filed accompanied by a copy of the decision granting § 1.47 status or, if a nonsigning person under § 1.47 has subsequently joined in a prior application, then a copy of the subsequently executed declaration must be filed. See 37 C.F.R. §§ 1.63(d)(1)–(3).*

*NOTE: A declaration filed to complete an application must be executed, identify the specification to which it is directed, identify each inventor by full name including family name and at least one given name, without abbreviation together with any other given name or initial, and the residence, post office address and country or citizenship of each inventor, and state whether the inventor is a sole or joint inventor. 37 C.F.R. § 1.63(a)(1)–(4).*

- ☐ Enclosed

Executed by

*(check all applicable boxes)*

- ☐ inventor(s).
- ☐ legal representative of inventor(s).  
37 CFR 1.42 or 1.43.
- ☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.
  - ☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. See item 13 below for fee.

- ☒ Not Enclosed.

*NOTE: Where the filing is a completion in the U.S. of an International Application or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.*

- ☒ Application is made by a person authorized under 37 C.F.R. 1.41(c) on behalf of all the above named inventor(s).

*(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently).*

- ☐ Showing that the filing is authorized.  
*(not required unless called into question. 37 CFR 1.41(d))*

## 6. Inventorship Statement

**WARNING:** If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

☐ The same.

or

☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,

☐ is submitted.

☐ will be submitted.

## 7. Language

**NOTE:** An application including a signed oath or declaration may be filed in a language other than English. An English translation of the non-English language application and the processing fee of \$130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(c).

☒ English

☐ Non-English

☐ The attached translation includes a statement that the translation is accurate. 37 C.F.R. 1.52(d).

## 8. Assignment

☒ An assignment of the invention to Nokia Mobile Phones Limited

☐ is attached. A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

☒ will follow.

**NOTE:** "If an assignment is submitted with a new application, send two separate letters—one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

**WARNING:** A newly executed "CERTIFICATE UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

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**9. Certified Copy**

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
United Kingdom	9814080.9	June 30, 1998
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

- ☒ is (are) attached.  
☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 13 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

#### 10. Fee Calculation (37 C.F.R. 1.16)

A. ☒ Regular application

CLAIMS AS FILED				
Number filed	Number Extra	Rate	Basic Fee 37 C.F.R. 1.16(a) \$760.00	
Total				
Claims (37 CFR 1.16(c)) $42 - 20 = 22$	X	\$ 18.00	396.00	
Independent				
Claims (37 CFR 1.16(b)) $8 - 3 = 5$	X	\$ 78.00	390.00	
Multiple dependent claim(s), if any (37 CFR 1.16(d))	÷	\$ 260.00		

- ☐ Amendment cancelling extra claims is enclosed.
- ☐ Amendment deleting multiple-dependencies is enclosed.
- ☐ Fee for extra claims is not being paid at this time.

**NOTE:** If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation \$ 1546.00

B. ☐ Design application  
(\$ 310.00—37 CFR 1.16(f))

Filing Fee Calculation \$\_\_\_\_\_

c. ☐ Plant application  
(\$480.00—37 CFR 1.16(g))

Filing fee calculation \$\_\_\_\_\_

[illegible]

- WARNING:** "Status as a small entity must be specifically established in each application or patent in which the status is available and desired. Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. The refiling of an application under § 1.53 as a continuation, division, or continuation-in-part (including a continued prosecution application under § 1.53(d)), or the filing of a reissue application requires a new determination as to continued entitlement to small entity status for the continuing or reissue application. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) of a prior application, or a reissue application may rely on a statement filed in the prior application or in the patent if the nonprovisional application or the reissue application includes a reference to the statement in the prior application or in the patent or includes a copy of the statement in the prior application or in the patent and status as a small entity is still proper and desired. The payment of the small entity basic statutory filing fee will be treated as such a reference for purposes of this section." 37 C.F.R. § 1.28(a)(2).

☐ Status as a small entity was claimed in prior application  
\_\_\_\_\_ / \_\_\_\_\_, filed on \_\_\_\_\_, from which benefit  
is being claimed for this application under:

and which status as a small entity is still proper and desired.

- Filing Fee Calculation (50% of A, B or C above)**

**NOTE:** Any excess of the full fee paid will be refunded if small entity status is established and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).

(complete, if applicable)

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13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.

(This and the surcharge required by 37 C.F.R. 1.16(e) can be paid subsequently.)

☒ Enclosed

☒ Filing fee

\$1546.00

☐ Recording assignment

(\$40.00; 37 C.F.R. 1.21(h))

(See attached "COVER SHEET FOR  
ASSIGNMENT ACCOMPANYING NEW  
APPLICATION".)

\$

☐ Petition fee for filing by other than all the  
inventors or person on behalf of the inventor  
where inventor refused to sign or cannot be  
reached

(\$130.00; 37 C.F.R. 1.47 and 1.17(i))

\$

☐ For processing an application with a  
specification in  
a non-English language

(\$130.00; 37 C.F.R. 1.52(d) and 1.17(k))

\$

☐ Processing and retention fee

(\$130.00; 37 C.F.R. 1.53(d) and 1.21(l))

\$

☐ Fee for international-type search report

(\$40.00; 37 C.F.R. 1.21(e))

\$

NOTE: 37 CFR 1.21(f) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(f) and this, as well as the changes to 37 CFR 1.53 and 1.78(a)(1), indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(f) must be paid, within 1 year from notification under § 53(f).

Total fees enclosed

\$ 1546.00

14. Method of Payment of Fees

☒ Check in the amount of \$ 1546.00

☐ Charge Account No. \_\_\_\_\_ in the amount of  
\$ \_\_\_\_\_

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

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## 15. Authorization to Charge Additional Fees

**WARNING:** If no fees are to be paid on filing, the following items should not be completed.

**WARNING:** Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☒ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. 16-1350.

☒ 37 C.F.R. 1.16(a), (f) or (g) (filing fees)

☒ 37 C.F.R. 1.16(b), (c) and (d) (presentation of extra claims)

**NOTE:** Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

☒ 37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)

☒ 37 C.F.R. §§ 1.17(a)(1)-(5) (extension fees pursuant to § 1.136(a)).

☐ 37 C.F.R. 1.17 (application processing fees)

**NOTE:** ". . . A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

☐ 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

**NOTE:** Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).

**NOTE:** 37 CFR 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . the issue fee. . . ." From the wording of 37 CFR 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

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**16. Instructions as to Overpayment**

*NOTE: "... Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).*

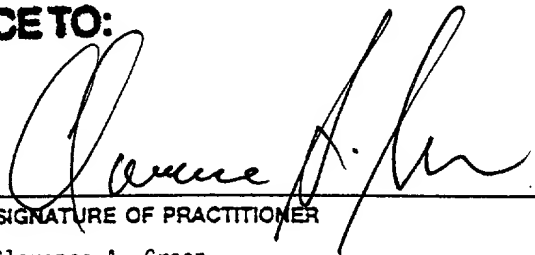
- ☒ Credit Account No. 16-1350  
☐ Refund

**SEND ALL CORRESPONDENCE TO:**

Reg. No. 24,622

Tel. No. (203) 259-1800

Customer No.

  
SIGNATURE OF PRACTITIONER

Clarence A. Green

*(type or print name of attorney)*

PERMAN & GREEN, LLP

P.O. Address

425 Post Road  
Fairfield, CT 06430

☐ **Incorporation by reference of added pages**

*(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)*

- ☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added \_\_\_\_\_

- ☐ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added \_\_\_\_\_

- ☐ Plus added pages deleting names of inventor(s) named in prior application(s) who is/are no longer inventor(s) of the subject matter claimed in this application.

Number of pages added \_\_\_\_\_

- ☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added \_\_\_\_\_

☒ **Statement Where No Further Pages Added**

*(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)*

- ☒ This transmittal ends with this page.

## Data Transmission in a TDMA System

### Background to the Invention

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The present invention relates to a method and apparatus for data transmission by a mobile station in a Time Division Multiple Access (TDMA) system. More specifically, the invention concerns multi-slot transmission of data services in such a system.

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TDMA is a fundamental digital telecommunication technology and forms the basis of cellular standards such as Global System for Mobile Communications (GSM). A TDMA system includes the basic subsystems of cellular radio systems including a switching network, base stations and mobile stations (MS). In a TDMA system the radio spectrum is divided into radio carrier frequencies typically spaced 30 kHz to 200 kHz apart. This spacing between the carrier frequencies is the nominal or effective bandwidth of the total multi-channel multiplexed signal. Digital techniques are employed at the base station and in the cellular radio to subdivide the time on each radio channel into time slots, i.e. the TDMA radio carrier waveform is divided into several different types of control and voice/data channels by the use of different time slots or shared portions of time slots. Time slots are the smallest individual time periods available to each mobile station. Each time slot can be assigned to a different mobile telephone, and the time slots can be dedicated or dynamically assigned. Voice or data information as well as access information are converted to digital information that is sent and received in bursts during the time slots. The burst of digital information can be encoded, transmitted, and decoded in a fraction of the time required to produce the sound. Therefore, only a fraction of the airtime is used by one channel, and other

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subscribers can use the remaining time slots on the radio channel. The result is that TDMA systems allow several mobile stations (MS) to operate simultaneously on a single radio carrier frequency because the mobile stations share the radio frequency by dividing their signals into slots.

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In the GSM system, eight mobile telephones are able to share a single 200 kHz bandwidth radio carrier waveform for voice or data communications. GSM uses a type of radio channel called a traffic channel (TCH) which carries voice, data, and control information. The TCH is organised into frames and time slot bursts, The entire repeating pattern of time slots is called a frame and comprises eight time slots assigned to eight different users. From each frame, each user is assigned to a particular time slot burst for reception, and a particular corresponding burst for transmission. Hence, GSM multiplexes (time shares) several users onto a single radio carrier frequency through use of distinct time slots from each frame to individual users. Thus the GSM radio channel structure allows multiple mobile stations to communicate on the same frequency by using different time slots on the radio channel.

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As is well understood, such intensified use of radio spectrum greatly multiplies subscriber capacity. A further advantage of digital cellular technology is its ability to support advanced high speed data services such as short message service (SMS), broadcast paging, imaging services and fax transmission.

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Data services ordinarily are communicated in the same way as voice signals, that is they are assigned a particular individual time slot in a frame and share the single bandwidth radio carrier with other users. However, whilst the transfer of voice signals must be on a real time basis (instantaneous), certain data services can be transferred on a non-real time basis (stored or delayed). For example because paging messages can be delayed for several minutes without significant disadvantages to the receiver of the message, it allows

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short paging messages to be placed in a queuing system. Voice services on the other hand cannot queue an incoming call for more than a few seconds otherwise it is likely that the caller would terminate the call.

- 5 Non-real time operability of data services allows transmission of the information to be treated with increased flexibility. This has led recently to the development of multi-slot data transfer capability. Multi-slot transmission is facilitated by the network, typically the base station, which controls channel allocation to users. If more than one slot in a frame is available (for instance
- 10 during a period of relative inactivity and the slots have not be allocated to other users) then the network may designate the available slots to the transfer of data services. Accordingly, the network will command the mobile station to transmit the data communication on more than one consecutive slot. The data can then be decoded from the multi-slot transmission in the network.

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#### Summary of the Invention

- The present invention aims to address the problems arising from multi-slot transmission, and accordingly, in one aspect, provides a method for
- 20 controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method comprising monitoring at least
- 25 one criterion associated with heat generated by the transmitter, providing a signal responsive to the at least one monitored criterion for controlling at least one output criterion of the transmitter.

- It has been noted by the present inventors that current design of mobile
- 30 station transmitters would not be able satisfactorily to cope with multi-slot

transmission. One particular drawback is that the output RF power amplifier in standard TDMA mobile stations are designed to transmit at a rate of one slot per frame. In multi-slot transmission, driving the power amplifier at increased rates introduces new design challenges. In particular, it has been anticipated

5 that driving the power amplifier for multi-slot transmission will introduce problems due to thermal effects. Specifically, if the junction temperature of the RF power amplifier exceeds its upper rating, then this would cause changes in the amplifier's operating characteristics and could lead to irreversible damage.

10 One approach to this problem could be to increase the power amplifier capacity and introduce further heat sinks in the mobile station. However, this would necessitate an increase in the size of the mobile station, which would be undesirable given the general trend towards more compact mobile stations.

15 The present inventors have recognised that an alternative approach is to limit the power output of the power amplifier while continuing to transmit in multi-slot mode by controlling the maximum allowed output power levels.

20 The maximum allowed power output of a mobile station transmitter depends on its allocated power classification, which is network controlled. The network chooses the transmission power of the mobile station, and commands to regulate it are issued to the mobile station. The network determines the required mobile station transmission power through reception level

25 measurements performed on the base station, taking into account the mobile station maximum transmission power as well as quality measurements done by the network; this last parameter helps to ensure that transmission quality is kept above some acceptance threshold.

At the start of a connection, the network chooses the initial value of the transmission power. Because the equipment of the user may be changed without warning the operator (subscription is linked to the SIM (Subscriber Identity Module), not to the mobile equipment), this indication must be given at the beginning of each new connection based on the RF power capability, known as the transmission power class, which refers to the maximum power the mobile station is able to transmit. This information is used for power control and handover preparation.

GSM has five power classmarks defining respective maximum output powers. Typical classes in GSM900 are class 2 for transportable mobile telephones (eg. vehicle-mounted equipment) with a maximum power output of 8 watts; hand portables are classified 3 through to 5 with maximum power outputs ranging from 5 to 0.8 watts.

Whilst the classmark is sent by the mobile station in the initial message, at the beginning of the data transmission it may happen that the classmark changes during the transmission. An example of this is mobile equipment consisting of a handheld part and a vehicle mounted part including an RF transmitter, with the possibility to connect and disconnect the two parts during a communication. Then the power class changes, and the new value must be provided to the network. To achieve this, a classmark change procedure must be executed. In the GSM specification the classmark change procedure is described in GSM 04.08 in section 3.4.10.

By means of the invention, if it is determined that the heat generated by the transmitter of the portable radio apparatus approaches or has for example exceeded a pre-determined limit, then the output of the transmitter is regulated to ensure that the transmitter remains safely within its operating range.



Instead of, and/or as well as, monitoring the temperature of the transmitter, it is possible to monitor the temperature of the portable radio communication apparatus itself, and then to regulate transmission based on this temperature reading.

Conveniently, maximum and/or minimum pre-determined limits could be set. Optionally, intermediate values can also be set.

10 In one embodiment, the method comprises controlling the output power of the transmitter based on the monitored temperature, preferably changing the portable radio communication apparatus power classmark when the monitored temperature exceeds a pre-determined upper limit. As a result, the power amplifier output of the transmitter is reduced so that the temperature of  
15 the power amplifier does not reach or exceed its rated value.

In a second embodiment, the method comprises controlling the number of data bursts transmitted on time slots in a frame, preferably decreasing the number of data bursts transmitted on time slots in a frame when the  
20 monitored temperature exceeds a pre-determined limit. Regulating the multi-slot transmission in this way protects the transmitter from overstretching its transmission capabilities.

If more than one heat generated determining criterion is monitored, then it is  
25 possible to provide more than one signal responsive to the monitored criteria, the signals then controlling respective output criteria of the transmitter.

It is preferred that the method is performed by the portable radio communication apparatus, which advantageously stores the pre-determined  
30 limits in memory registers. Hence the operation of the transmission of the

transmitter can be controlled by the portable radio communication apparatus automatically and independently from the network.

5 Optionally, the method can be performed by the radio communication network.

10 In a further aspect of the invention, there is provided a method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method comprising monitoring the number of data bursts transmitted on time slots in a frame, comparing the monitored number with a pre-determined limit, and changing the operation of the transmitter if  
15 the monitored number falls outside the pre-determined limit.

20 According to this aspect of the invention, if it is determined that the transmitter of the portable radio apparatus has for example exceeded a pre-determined limit of data bursts in a particular frame, then the operation of the transmitter can be regulated to account for this and adjusted accordingly.

25 In a preferred embodiment, the monitoring of the number of data bursts transmitted on time slots in a frame is performed over a predetermined period of time or pre-determined number of frames.

If the monitored number of transmitted data bursts exceeds a pre-determined limit then the output power of the transmitter can be decreased, advantageously by changing the classmark of the portable radio communication apparatus. As a result, the maximum available output power

amplifier output of the transmitter is reduced so that the temperature of the power amplifier does not reach or exceed its rated value.

5 This class mark change can occur either in the call set-up or during high speed data transmission typically, but not restricted to, the moment when the number of used time slots is down or upgraded, or the temperature of the transmitter will reach a given limit.

10 The invention includes a method for controlling a transmitter of a portable radio communication apparatus, the portable radio communication apparatus communicating with a radio communication network over a radio channel comprising a plurality of time slots, and the transmitter transmitting data bursts during one or more of said time slots, the method comprising monitoring the transmission power level and comparing the monitored transmission power level with a pre-determined limit and changing the transmission power level of the communication apparatus based on the monitored transmission power level.

20 By continually monitoring the transmission power level, and comparing this with pre-determined values, the transmission level of the portable radio communication apparatus can be dynamically optimised.

25 The invention extends to radio systems and portable radio communication apparatus comprising means for performing the methods as described herein.

#### Brief Description of the Drawings

The invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 is a block diagram of one embodiment of the present invention;

Figure 2 is a block diagram illustrating in greater detail the embodiment of Figure 1;

5

Figure 3 is a schematic diagram of network originated resource upgrading in HSCSD; and

Figure 4 is schematic diagram of user initiated service level up and  
10 downgrading.

#### Detailed Description of the Drawings

In the block diagram cellular telephone system shown in Figure 1, a mobile  
15 station 10 communicates with the network 12, transferring data and digitised voice signals in a two way radio communication link. The cellular network 12 typically comprises an array of base stations which are linked together either directly or indirectly via mobile switching centres, and which enable telephone calls to be routed between mobiles stations as well as landline telephones.

20

The mobile station 10 is equipped with the standard features associated with a mobile communication device: a keypad for dialling numbers, accepting a call, terminating a call, storing telephone numbers, and so on; a microphone for converting sound pressure waves into electrical signals, and a  
25 loudspeaker for converting electrical signals into sound pressure waves; an antenna for radiating electromagnetic waves at transmission frequencies during transmission, and during reception for converting received electromagnetic waves at reception frequencies into electrical signals. The mobile station 10 also includes an RF block 14 comprising a receiver 16,  
30 synthesizers 18 and a transmitter 20.

It has previously been explained that in a TDMA system, and in particular GSM, a recent development in data services has been that of multi-slot transmission, for example, approaches such as High Speed Circuit Switched Data (HSCSD) and General Packet Radio Services (GPRS). Briefly, HSCSD is based on the use of up to 8 time slots per TDMA frame for one communication, thus providing for higher data transmission speeds. Typical applications of HSCSD include, facsimile, file transfer, electronic mail, video and distribution services. GPRS provides high speed packet radio access for GSM mobile stations and routing protocols for the GSM network. The relevant GSM standards of HSCSD and GPRS are GSM 02.34, 03.34 and GSM 03.64 respectively.

In a multi-slot transmission operation, the transmitter 20 outputs on more than one time-slot per TDMA frame. The power amplifier of the transmitter accordingly is driven at an increased rate compared to normal transmission at one slot per frame. This leads to an increase in the operating temperature of the power amplifier. If multi-slot transmission is sustained the temperature of the power amplifier will continue to rise. If unchecked, the rise in operating temperature of the power amplifier will cause damage to it.

Thus in one embodiment of the present invention the transmitter power amplifier (or adjacent area) is provided with a temperature sensor 21 (see Figure 2) for monitoring the temperature of the transmitter 20, and in particular the power amplifier. The temperature sensor 21 continually takes a reading of the temperature of the transmitter and feeds this reading, either continually or periodically, to a dynamic classmark control system 22 which includes an algorithm for deciding the operation of the transmitter. Specifically, the algorithm can decide the maximum allowed output power level and/or the maximum allowed number of transmitted bursts per TDMA frame.

The control system 22 stores certain system parameters and operating characteristics, such as information about the power amplifier including operating temperature limits and pre-defined maximum transmission power levels. Such information is stored in the mobile station's non-volatile memory area or hardware registers. This would normally be factory set, but could be user defined. The control system 22 further includes a comparator which takes the sensed temperature reading and compares this against the stored preferred operating temperature range of the power amplifier. On the basis of the result of the comparator, the control system 22 decides whether or not to change the maximum allowed power output or the burst rate at which the power amplifier is being driven. If the result from the comparator is that the sensed temperature of the power amplifier is within its operating range then the control system 22 directs no changes in the normal transmitter operation. If however the sensed temperature is outside its preferred operating range then the control system 22 commands a change in the operation of the transmitter to ensure that the upper working limit of the power amplifier is not reached.

One approach is that it is the mobile station power classmark that is dropped, as a result reducing the maximum allowed power output of transmitter and thereby demanding less from the power amplifier. Another approach is that the number of multi-slot transmissions per frame is decreased. This is particularly beneficial where a drop in the power classmark could risk losing the connection altogether.

In and HSCSD operation, typically the right moment for classmark change is after the resource upgrading procedure, which can be initiated either by the network or on the mobile station side. The implementation is mainly adding a

control entity for taking care of the mobile station classmark during the data transmission operation. Figures 3 and 4 illustrate HSCSD operation.

In the GPRS communication, the mobile station delivers its Mobile Radio Capabilities, including information about its power class, in an Attach procedure. This procedure is carried out when the mobile station initiates the GPRS "session". This information is stored in the Serving GPRS Support Node (SGSN) and the SGSN delivers it to the base station system when the mobile moves around the network. The Mobile Radio Capability information is provided to the SGSN by the mobile station also in the Routing Area Update, i.e. when the mobile station is moving around the network. It is also possible that the Mobile Radio Capability information is delivered by the mobile station to the base station when the mobile station enters the GPRS transfer mode, i.e. every time the mobile is going to send or receive data and when the physical radio channel is needed. This can be done for example in the Packet Resource Request message that is transmitted on the Packet Associated Control Channel (PACCH). These kinds of messages may be transmitted on the channel given for the mobile station, instead of user data messages. This procedure allows the mobile station to change its power class dynamically during the GPRS "session".

In a second embodiment, a direct temperature sensor is no longer employed, and the temperature of the transmitter is determined or estimated by indirect means. In this embodiment, a transmission monitor is provided for counting the number of consecutive multi-slot time slot transmissions effected by the transmitter. The monitor also counts the number of frames of multi-slot transmission. Accordingly, in a given time period, the total output burst rate of the power amplifier and the power dissipation which turns to heat can be continually determined and updated. The monitoring can be performed on a continually updating and dynamic basis. This can be fed into the control

system 22 and compared with pre-defined operating values concerning the number of multi time slot transmissions over a certain number of frames. If the number of transmissions over a certain period of time is within the operating range of the power amplifier then the control system 22 allows it to continue the transmission. However, if the counted transmission approaches or exceeds the upper limit of transmissions over a period of time or number of frames, (known to cause an unacceptable temperature rise of the transmitter, or mobile station when operating at high output power levels), then the control system 22 effects a change in the transmitter: either reducing the number of multi-slot transmissions or changing the mobile station power classmark.

For example, it may be that the transmitter is transmitting in GSM at a rate of 8 time slots per frame, the mobile station will have stored in a memory the number of frames in which 8 time slots can be transmitted on before the power amplifier begins to reach its critical limit. This information is used by the control system in determining the operation of the transmitter. It will be understood that a power amplifier operating at 8 time slots per frame will reach its critical limit sooner than if it was operating at say only 4 time slots per frame. Equally, at 4 time slot transmissions per frame the power amplifier can output a greater number of consecutive frames at this rate than operating at 8-time slot transmission per frame before approaching its critical value. These critical values are stored in an on-board memory facility which either can be readily accessed by the control system or form part thereof.

The control system ensures that the maximum allowed transmission power level (ie. the MS classmark or the number of bursts per TDMA frame) is according to the predefined criteria.

It should be noted that whilst the feedback control systems of the invention have been described in the context of a portable radio communication device, such



systems, and indeed aspects of the systems, can be implemented and supported in the network.

- Furthermore, it will be readily understood that alternative arrangements to those described above with reference to the specific embodiment can be made within the inventive concept as defined in the appended claims.

- Each feature disclosed in this specification (which term includes the claims) and/or shown in the drawings may be incorporated in the invention independently of other disclosed and/or illustrated features.

The appended abstract as filed herewith is included in the specification by reference.

- What is claimed is:-

Claims

1. A method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method comprising monitoring at least one criterion associated with heat generated by the transmitter, providing a signal responsive to the at least one monitored criterion for controlling at least one output criterion of the transmitter.
2. A method according to claim 1, wherein one of the at least one monitored criterion comprises the temperature of the transmitter.
3. A method according to claim 1, wherein one of the at least one monitored criterion comprises the number of transmitted data bursts in a frame.
4. A method according to claim 1, wherein one of the at least one output criterion comprises the power output of the transmitter.
5. A method according to claim 4, wherein if the monitored criterion exceeds a predetermined limit then the power output of the transmitter is decreased.
6. A method according to claim 5, wherein the maximum available power output of the transmitter is decreased by changing the power classmark of the portable radio communication apparatus.

7. A method according to claim 1, wherein one of the at least one output criterion comprises the number of data bursts transmitted in a frame.
8. A method according to claim 7, wherein if the monitored criterion exceeds a predetermined limit then the number of data bursts transmitted in a frame is decreased.
9. A method according to claim 1, wherein the monitoring step is performed by the portable radio communication apparatus.
- 10.A method according to claim 1, wherein the monitoring step is performed by the radio communication network.
- 11.A method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots in a frame, the method comprising monitoring the number of data bursts transmitted on time slots in a frame, comparing the monitored number with a pre-determined limit, and changing the operation of the transmitter if the monitored number falls outside the pre-determined limit.
- 12.A method according to claim 11, wherein the monitoring of the number of data bursts transmitted on time slots in a frame is performed over a predetermined period of time or pre-determined number of frames.
- 13.A method according to claim 11, wherein changing the operation of the transmitter comprises controlling the power output of the transmitter.

- 14.A method according to claim 13, wherein controlling the power output of the transmitter comprises changing the power classmark of the portable radio communication apparatus.
- 5 15.A method according to claim 11, wherein changing the operation of the transmitter comprises controlling the number of data bursts transmitted on time slots in a frame.
- 10 16.A method according to claim 15, wherein controlling the number of data bursts transmitted on time slots in a frame comprises decreasing the number of data bursts transmitted on time slots in a frame if the monitored number of transmitted data bursts exceeds a pre-determined limit.
- 15 17.A method according to claim 11, wherein the method steps are performed by the portable radio communication apparatus.
- 18.A method according to claim 11, wherein the method steps are performed by the radio communication network.
- 20 19.A method for controlling a transmitter of a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the transmitter transmitting data bursts during one or more of said time slots, the method comprising
- 25 monitoring the transmission power level of the communication apparatus and comparing the monitored transmission power level with a pre-determined limit and changing the maximum allowed transmission power level in response to the monitored transmission power level.

20.A method according to claim 19, wherein the monitored transmission power level is compared with a pre-determined power transmission level and if the monitored transmission power level is above said pre-determined level then the maximum allowed output transmission power level is decreased by changing the power classmark of the portable radio communication apparatus.

21.A radio telephone system comprising a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, the system including monitoring means for monitoring at least one criterion associated with heat generated by the transmitter, at least one output criterion of the transmitter being responsive to the monitored criterion.

22.A radio telephone system according to claim 21, wherein one of the at least one monitored criterion comprises the temperature of the transmitter.

23.A radio telephone system according to claim 21, wherein one of the at least one monitored criterion comprises the number of transmitted data bursts in a frame.

24.A radio telephone system according to claim 21, wherein one of the at least one output criterion comprises the power output of the transmitter.

25.A radio telephone system according to claim 24, wherein if the monitored criterion exceeds a predetermined limit then the power output of the transmitter is decreased.

26.A radio telephone system according to claim 25, wherein the maximum available power output of the transmitter is decreased by changing the power classmark of the portable radio communication apparatus.

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27.A radio telephone system according to claim 21, wherein one of the at least one output criterion comprises the number of data bursts transmitted in a frame.

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28.A radio telephone system according to claim 26, wherein if the monitored criterion exceeds a predetermined limit then the number of data bursts transmitted in a frame is decreased.

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29.A radio telephone system according to claim 21, wherein the portable radio communication apparatus includes the monitoring means.

30.A radio telephone system according to claim 21, wherein the radio communication network includes the monitoring means.

20

31.A radio telephone system comprising a portable radio communication apparatus for communication in a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, the system including monitoring means for monitoring the number of data bursts transmitted on time slots in a frame, a comparator for comparing the monitored number of transmitted data bursts with a pre-determined limit, and a processor for changing the operation of the transmitter if the monitored number of transmitted data bursts falls outside the pre-determined limit.

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32.A radio telephone system according to claim 31, wherein the monitoring means monitors the number of data bursts transmitted over a pre-determined period of time or pre-determined number of frames.

5

33.A radio telephone system according to claim 31, wherein the processor controls the power output of the transmitter.

10

34.A radio telephone system according to claim 33, wherein the processor controls the power output of the transmitter by changing the power classmark of the portable radio communication apparatus.

15

35.A radio telephone system according to claim 31, wherein the processor controls the number of data bursts transmitted on time slots in a frame.

20

36.A radio telephone system according to claim 35, wherein the number of data bursts transmitted on time slots in a frame is decreased when the monitored number of transmitted data bursts exceeds a pre-determined limit.

25

37.A radio telephone system according to claim 31, wherein the portable radio communication apparatus includes the monitoring means, comparator and the processor.

30

38.A radio telephone system according to claim 31, wherein the radio communication network includes the monitoring means, comparator and the processor.

39.A radio telephone system comprising a portable radio communication apparatus for communication in a radio communication network employing

transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, the system including monitoring means for monitoring the transmission power level of the transmitter and comparing means for comparing the monitored transmission power level with a pre-determined limit and a processor for changing the maximum available transmission power level of the communication apparatus in response to the monitored transmission power level.

10

40. A radio telephone system according to claim 39, wherein the monitored transmission power level is compared with a pre-determined power transmission level and if the monitored transmission power level is above said pre-determined level then the maximum allowed output transmission power level is decreased by changing the power classmark of the portable radio communication apparatus.

15

41. A portable radio communication apparatus operable to communicate with a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a transmitter for transmitting data bursts during one or more of said time slots in a frame, and including monitoring means for monitoring at least one criterion associated with the heat generated by the transmitter, at least one output criterion of the transmitter being responsive to the monitored criterion.

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42. A method for controlling a portable radio communication apparatus for communication with a radio communication network employing transmission by a plurality of carrier frequencies in frames each consisting of a predetermined number of time slots, the apparatus having a

30





**Abstract****Data Transmission in a TDMA System**

In TDMA systems it is possible to transmit data on more than one consecutive slot per frame. This introduces increased workloads on the power amplifier of the transmitter of the mobile station. To prevent the power amplifier from overheating, temperature sensing means are incorporated into the mobile station which output to a control system comprising a comparator and feedback means which together regulate the operation of the transmitter if the power amplifier approaches or exceeds its upper rated operating value. Thereby preventing the power amplifier from damage.

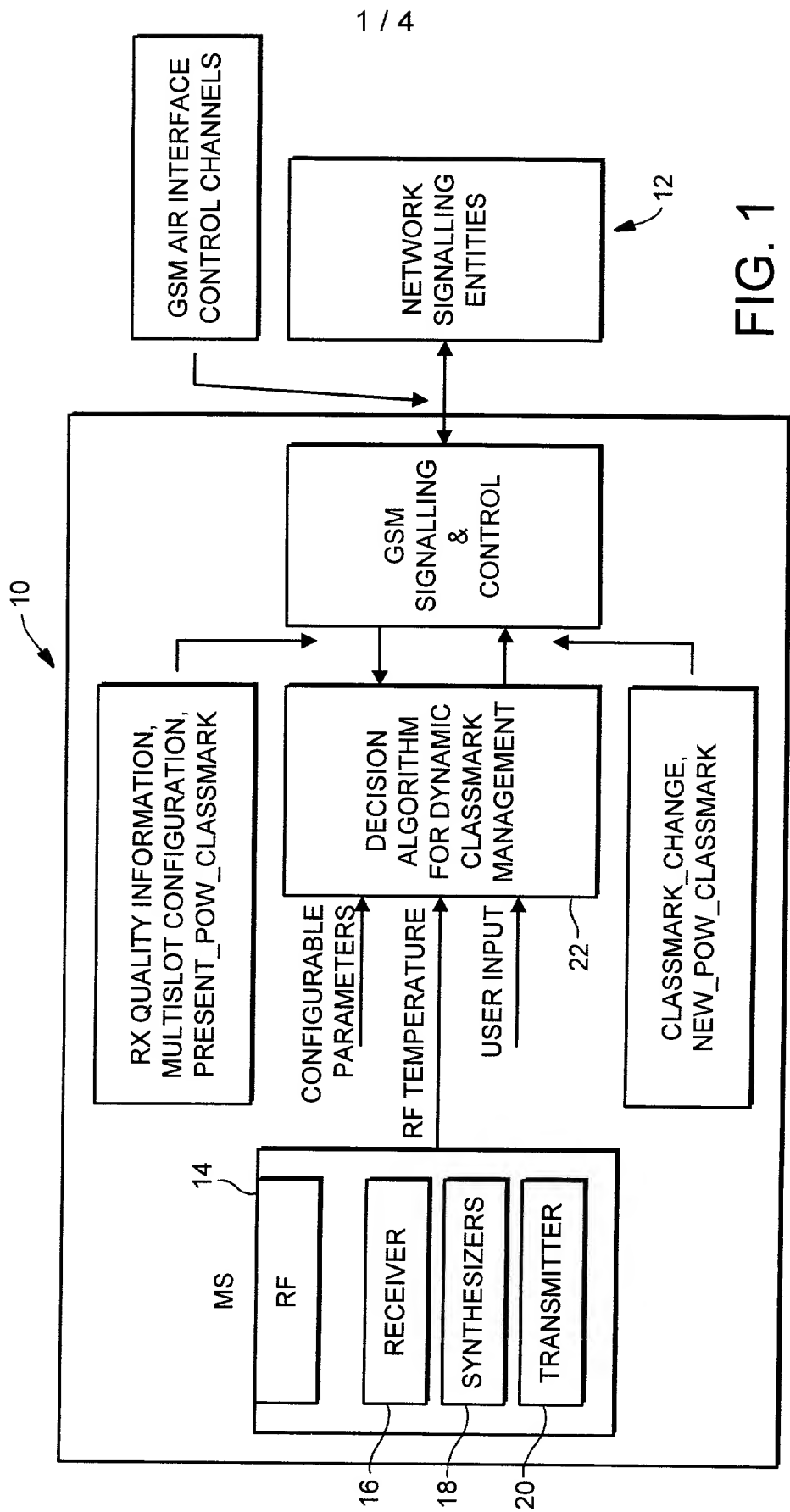


FIG. 1

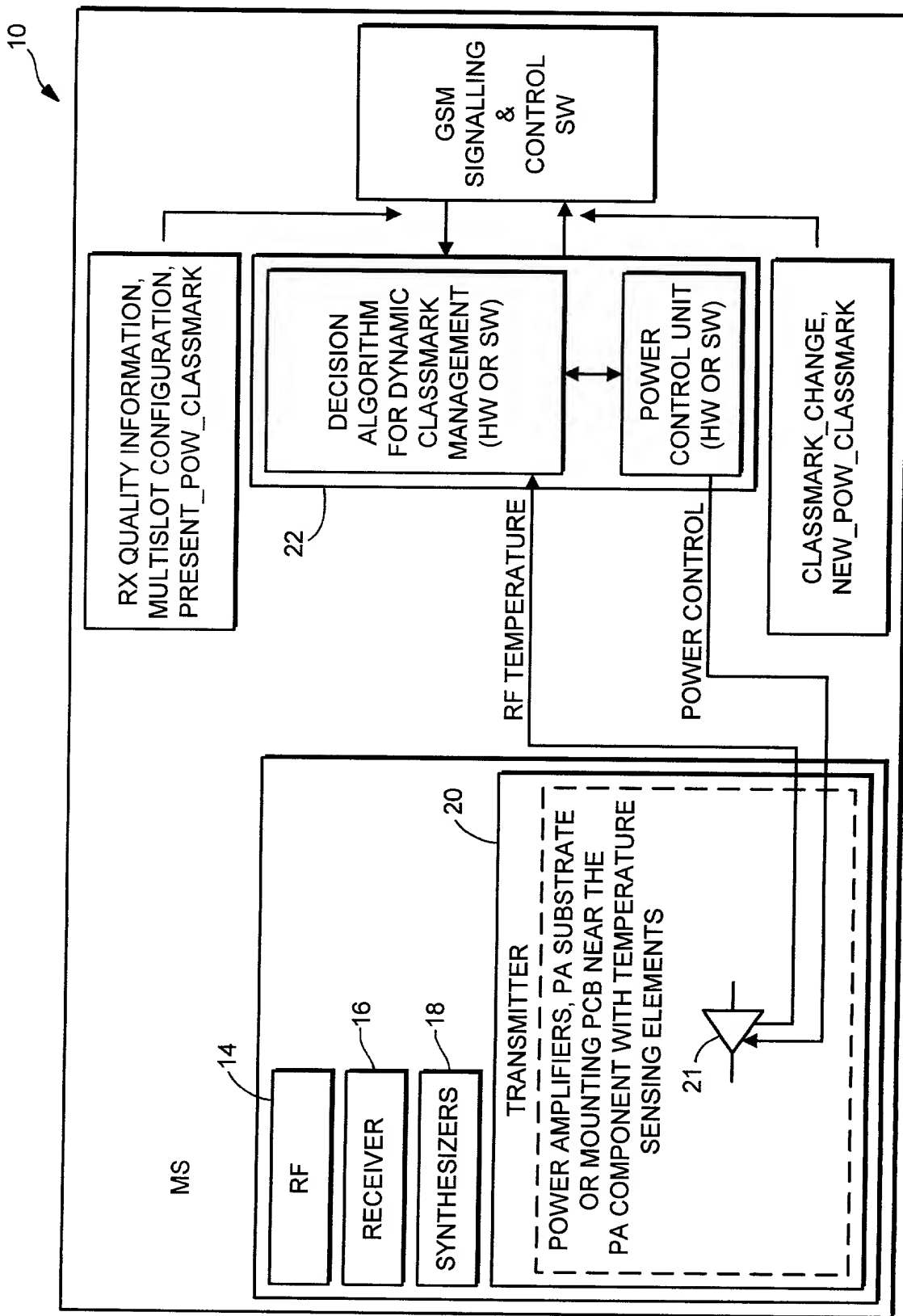
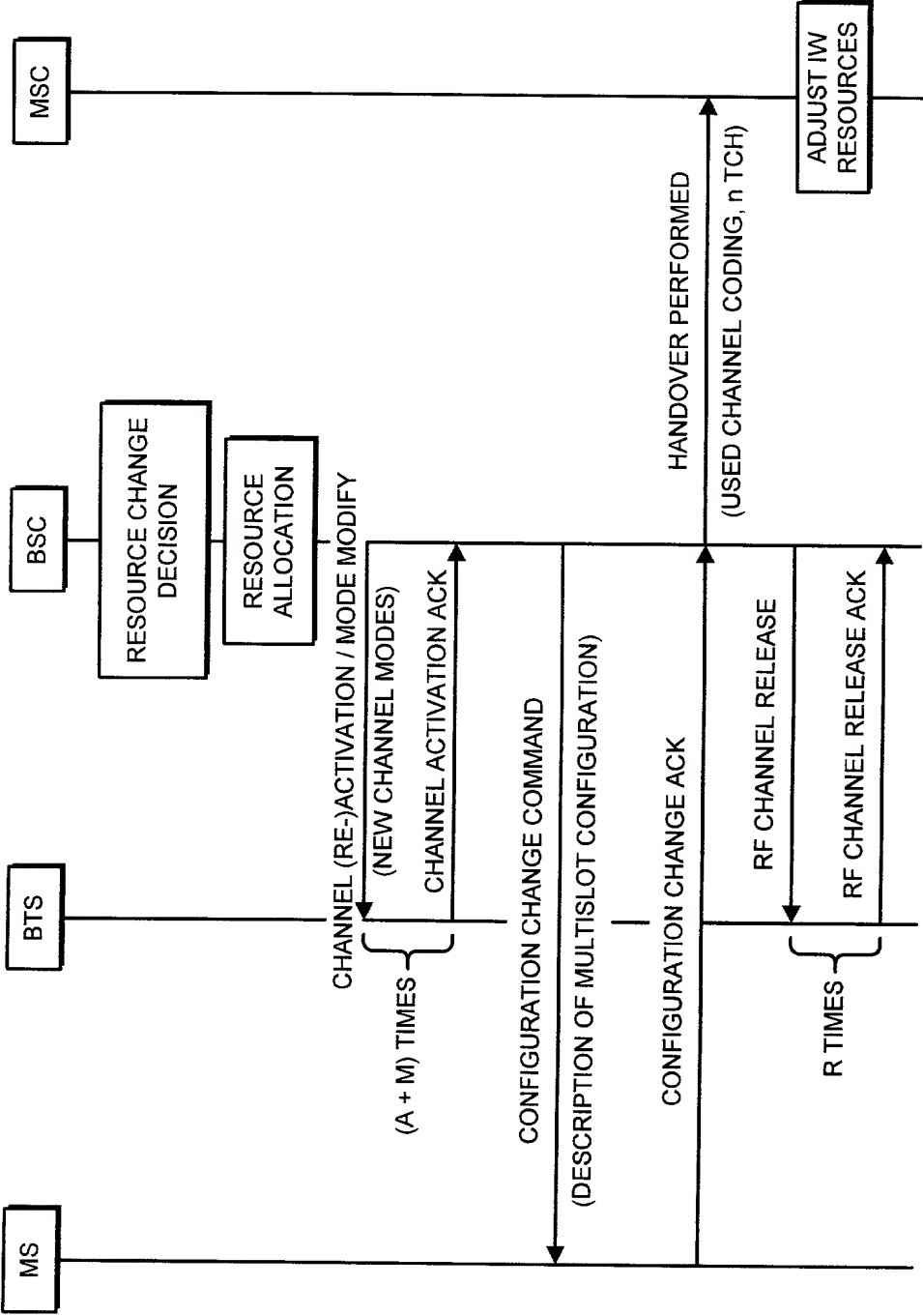


FIG. 2



A = NUMBER OF TIME SLOTS ADDED TO THE CONNECTION  
R = NUMBER OF TIME SLOTS RELEASED FROM THE CONNECTION  
M = NUMBER OF TIME SLOTS MODIFIED  
n = NUMBER OF TIME SLOTS AFTER UPGRADING / DOWNGRADING

FIG. 3

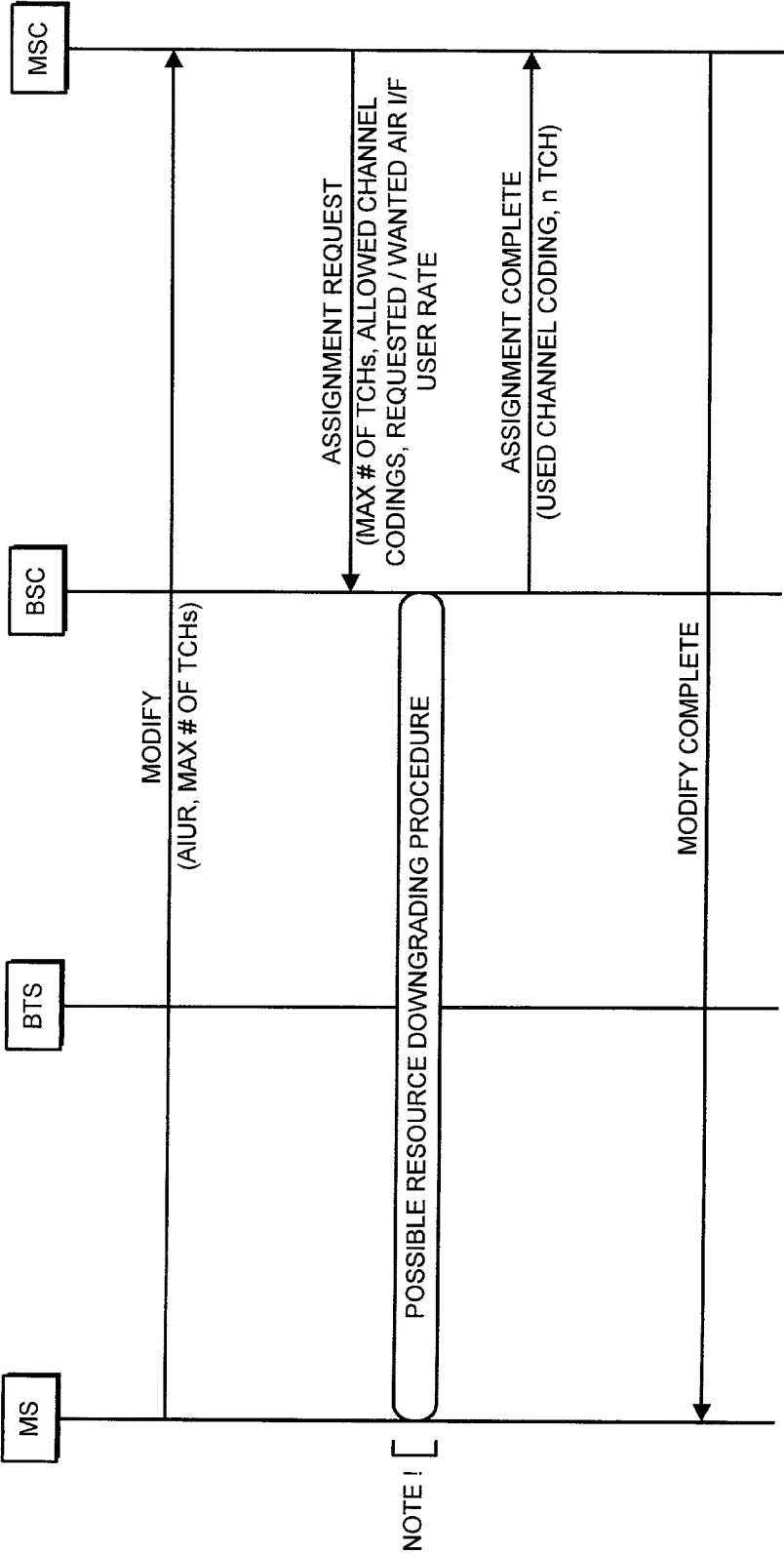


FIG. 4

AIUR = AIR INTERFACE USER RATE  
n = NUMBER OF TIME SLOTS ALLOCATED

NOTE ! THE RESOURCE LEVEL IS DOWNGRADED, IF IT IS CONTRADICTION WITH THE NEW SERVICE LEVEL